THE EFFECT OF ADHESIVE STRAPPING ON ANKLE ACTION

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Introduction

The purpose of adhesive strapping before athletic events is to protect a joint without interfering with its action. The strips of tape are supposed to act as outside ligaments, protecting and reinforcing the natural ligaments. In order to achieve this, the maximum range of movement of the joint has to be somewhat reduced without encroaching upon the range needed for athletic performance.

If the range of movement in a joint is reduced excessively, it will deleteriously affect the performance. Thus a trainer is expected to tape athletes so that they get protection without losing efficiency.

The purpose of the present report is to suggest a method for an objective evaluation of this expectation.

It is obvious that an investigation of this kind should begin with study of action of each joint separately. Moreover, each possible direction of movement in the joint should be analyzed separately. Since the ankle joint is one of the joints most frequently strapped, it was decided to start investigation with this joint. Although there are several possible movements in the ankle joint; namely, eversion and inversion, flexion* and extension, and although the first two are more important from the standpoint of athletic injuries than the last two, it was decided to study the effect of strapping on the flexion and extension. This was done because it is simpler to evaluate flexion and extension than eversion and inversion.

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* In this report, flexion means dorsiflexion and extension means plantar flexion.

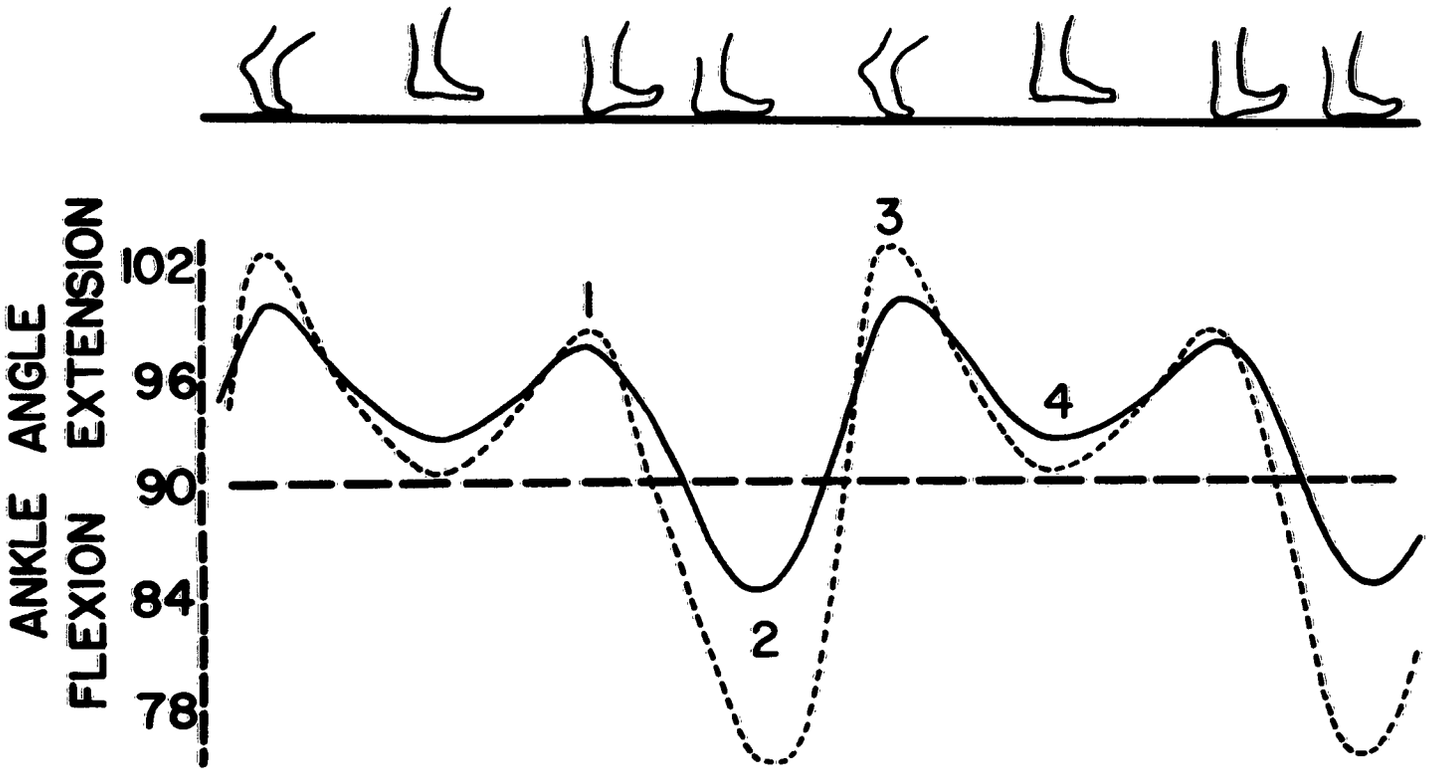


Fig. 1. GONIOGRAMS OF ANKLE ACTION DURING WALKING (—) AND RUNNING (---). The subject was barefoot. The numbers are reference points corresponding to positions of the foot shown above the goniograms. 1, heel contact; 2, full support; 3, toe take off; 4, swing mid-point.

Two approaches were used:

1. Recording electrogoniometrically the maximum range of flexion and extension in the unstrapped and strapped ankle joint before and after physical activity. Also recording the degrees of flexion and extension during walking and running.
2. Timing agility runs.

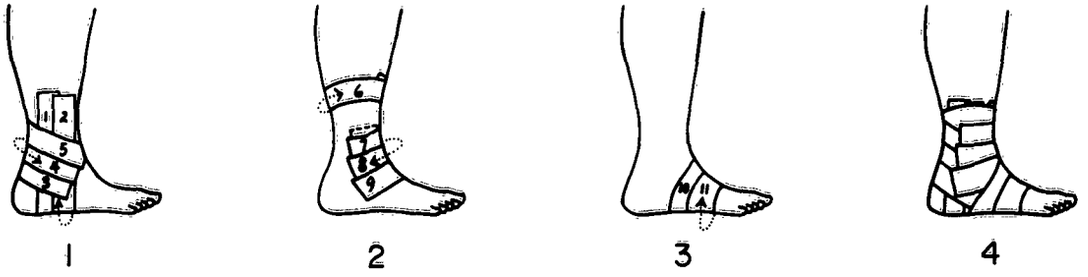
Materials and Methods

1. Elgon (electrogoniometer). A modified elgcn described by Gollnick and Karpovich[1] was used. The technique selected was essentially the same as described by Karpovich et.al.[2] Records were made on a portable Heiland Visicorder Model #906. The elgon was placed on the lateral aspect of the foot so that the center of the potentiometer was over the center of the lateral malleolus. One chassis arm was pointed toward the head of the fibula and the other toward the fifth metatarsal. In the taped subjects, the elgon was placed over the tape in the same relative position as on an untaped foot. A sample of goniograms may be seen in Figure 1.
2. Strapping. Three taping techniques were used: The Johnson & Johnson Tape Cast, the Springfield Modified, and the Lonn-Mann. (See Figure 2). All taping was done with Johnson & Johnson Zonas regular tape.

The lower legs were shaved and cleaned, and a

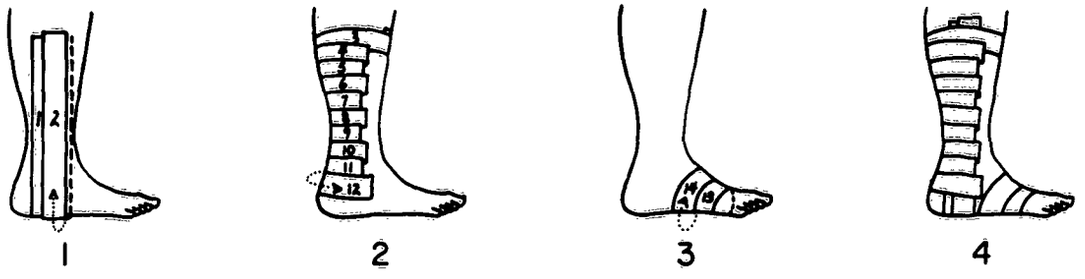
JOHNSON & JOHNSON TAPE CAST

A



LONN – MANN

B



SPRINGFIELD MODIFIED

C

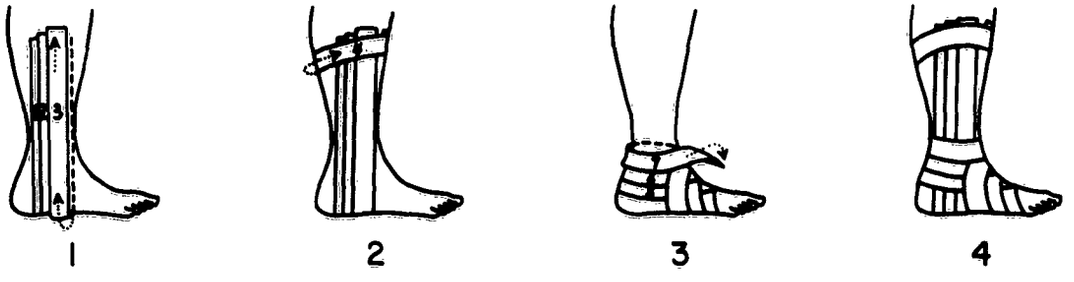


Fig. 2. THREE DIFFERENT TYPES OF TAPE TECHNIQUES.

cherry resin solution (225 gm. of cherry resin to 1 gallon of 90% alcohol) was applied to the skin. This is a common practice at Springfield College in order to assure better adhesion of tape to a perspiring skin.

The foot was placed on a special stand which supported only the heel and the metatarsal bones, leaving an open space in-between. Both ankles were strapped.

A. The Johnson & Johnson Tape Cast with 2 inch wide tape. (Figure 2A). It consists of overlapping stirrups, and short, open oblique strips anchoring on the lower leg. Closed circular strips around the instep pull the foot into eversion.[3]

B. The Lonn-Mann Taping Technique with 2 inch wide tape. (Figure 2B). It consists of overlapping stirrups anchoring on the lower leg, and a number of circular strips left open on the forepart of the lower leg. Closed circular strips around the instep pull the foot into eversion.[4]

C. The Springfield Modified Tape Technique with 1½ inch wide tape. (Figure 2C). It consists of a series of overlapping stirrups anchoring on the lower leg, and figure-of-eight strips to pull the foot into eversion.[5]

3. Agility Runs. The diagram of the agility run course is given in Figure 3. The subject started from a standing

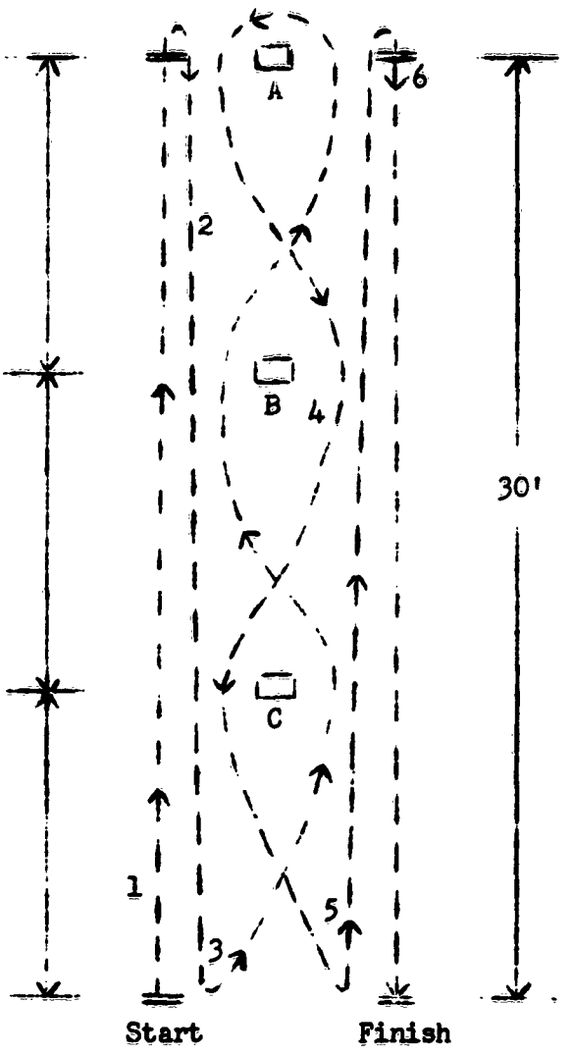


Figure 3. Diagram of the Agility Run Course. A, B, and C are TV trays placed 10 feet apart. The subject follows from start to finish, the lines 1, 2, 3, 4, 5, and 6. The total distance is approximately 190 feet.

position, made two straight runs, then two runs weaving around three TV trays placed 10 feet apart in the mid-line of the course, and then two more straight runs. Since each straight run was 30 feet long, the subject ran about 190 feet.

Each subject ran five times on six different days. Two runs each day were made without the ankles being strapped, and the other runs with ankles strapped by each of the three different techniques. The runs on the first day were given for orientation purposes only; and the first run on each of the other five days was given for the purpose of a formal warm-up. It was not timed. The remaining four runs, one without and three with strapping, were timed. Thus each subject was tested five times untaped and five times with each style of strapping.

4. Measuring the range of full movement of the ankle joint in flexion-extension, and the amplitude of a forced flexion.

A. Maximum range. The subject sat on the table. The ankles were not taped. He was asked to perform maximum extension and flexion of the feet five times. This was recorded by elgons attached to each foot.

B. Forced flexion. The subject was then asked to do a one-leg-squat five times and the amount of ankle flexion was recorded by an elgon during each squat. The one-leg-squat consisted of a squat on one leg until the thigh was parallel to the floor. The other leg was extended forward. Although both legs were tested, the

data were used only from the preferred leg.

C. Next, the elgons were removed and the subject made agility runs. Immediately after completion of each run, elgons were placed on the ankles and the maximum range of movement and the degree of forced flexion were measured.

D. All these tests were repeated on taped subjects, a few minutes after strapping and again after completion of each agility run.

5. Recording the degrees of movement in the ankle joint during walking and running.

Walking and running were done at 3 and 6 mph respectively, on an electrically driven treadmill at zero elevation. Each bout lasted at least two minutes, and each activity was repeated three times. Walking preceded running. Records of the ankle action were made during 15-20 steps at the end of each minute.

6. Subjects were 10 Springfield College students: five for agility runs and five for the tests during walking and running on the treadmill.

Results and Discussion

1. Effects of strapping and agility running on the maximum range of flexion-extension in the ankle joint.

Table 1 gives the means of five tests on five subjects for each experimental condition.

Strapping did reduce the degree of maximum flexion-extension in the ankle joint. For the Johnson & Johnson

strapping, it was 16.5°, for the Lonn-Mann 9.0°, and for the Springfield Modified 18.1°. All these decreases were statistically significant: $p<0.01$ for the Johnson & Johnson and the Springfield Modified, and $p<0.05$ for the Lonn-Mann strapping.

If an attempt is made to regain by force a full range of movement, strapping will obviously offer resistance during that part of the angular amplitude which is lost through reduction. In other words, the amount of reduction caused by a strapping represents that part of the angular movement at the joint during which the strapping supplies protection until the full range is reached. Although strapping also offers protection after the full normal range has been reached, this factor was not measured in the present study.

Expressed in per cent of the maximum range for the unstrapped ankle, the margin of protection offered by strappings used in this study varies as follows: for the Johnson & Johnson, 31.2 per cent; for the Lonn-Mann, 17.0; and for the Springfield Modified, 34.3.

After the five one-leg-squats and the agility run, the amplitude of ankle joint movement increased only slightly: for the Johnson & Johnson strapping, it was 3.4°; for the Lonn-Mann, 2.7°; and for the Springfield Modified, 4.6°. These increases were not statistically significant, $p>0.10$.

In spite of these increases the range of motion in the taped ankle remained smaller than in the untaped one.

For the Johnson & Johnson, the difference was 13.1°, $p < 0.01$; for the Lonn-Mann, 6.3°, $p < 0.10$; and for the Springfield Modified, 13.8°, $p < 0.01$. These differences represent the protection margins for each type of strapping. Expressed in per cent, the maximal range for the untaped ankle, these protection margins were as follows: for the Johnson & Johnson, 24.9; for the Lonn-Mann, 12.0; and for the Springfield Modified, 26.2.

The protective margin after an agility run and five additional squats was reduced by 5 to 8 per cent.

Thus, elgons provide a convenient device which allows one to observe the effect of a physical activity upon strapping during that activity. (To record the degrees of angles during free running, telemetry should be used.)

In the present study the protective margin was determined only after a brief period of activity. After longer and more vigorous activity, the results may be different.

Rarick et.al.[6], using a different procedure, found that, after 10 minutes of vigorous activity, as much as 40 per cent of the net supporting strength of the strappings for the ankle joint was lost. They also plotted graphs for each of their five subjects showing the amount of external force necessary to produce various amplitudes of simultaneous plantar flexion and

inversion. This was done in unstrapped condition, and with a basket weave-heel-lock strapping, before and after exercise. It is of interest to note that the curves representing forces needed to cause movement in the ankle were roughly parallel. This means that the drop in resistive support was the same for the small as for the large amplitude.

2. Effect of strapping on amplitude of movement in the ankle caused by forced flexion.

Table 2 indicates that strapping reduced the amount of forced flexion which could be obtained with five one-leg-squats. The amount of reduction was approximately the same for each strapping: for the Johnson & Johnson 9.6°, $p < 0.10$; for the Lonn-Mann 8.5°, $p < 0.05$; and for the Springfield Modified 9.8°, $p < 0.02$.

After the agility run, the degrees obtainable during a forced flexion increased very little and were not statistically significant. For the Johnson & Johnson strapping it was 1.7°, for the Lonn-Mann 4.6°, and for the Springfield Modified 2.4°. This was not surprising because these three techniques had not been designed to resist flexion of the ankle.

3. Flexion-extension of untaped and taped ankle joints in walking and running.

The pertinent data are presented in Table 3. For better understanding, Figure 1 should be consulted. During three consecutive two-minute walks at 3 mph, the ankle angles formed at all reference points were about

the same, regardless of whether the subjects were taped or not.

The same was true for the three consecutive two-minute runs at 6 mph. Attention is called to the fact that the range of movement (flexion-extension) of taped ankles during walking and running was only slightly smaller than that of untaped ankles. During walking and running the range of ankle movement was only 35 and 57 per cent of the maximal range; thus the protective function of strapping covers respectively 65 and 43 per cent of the maximum range.

4. Agility run time.

The average times for five trials for each of the four experimental conditions are given in Table 1. They were 14.92 sec. for the untaped and 15.02-15.10 sec. for the taped conditions. Statistical analysis showed that the difference was not statistically significant, $p > 0.10$. It should be noted here that subjects number two and five, with a history of injury to the ankle, had a tendency to run faster when strapped.

Conclusions

1. Strappings of the ankle, described in this report, reduced the amplitude of flexion-extension from 9 to 18.1°. This reduction is a measure of protection offered by the strappings within the limits of normal range of movement. Expressed in per cent of maximal range of movement, the protective action of strapping covers from 17 to 34.3 per

cent of this range. Obviously this protection extends to movement beyond this range.

2. Strapping caused little protection for a forced flexion of the ankle. This should be expected, because the types of strappings used in this study were not designed for this purpose.
3. During walking and running, only a fraction of the maximal range was used: 35 and 57 per cent respectively. This means that, within experimental conditions set in this study, strapping of the ankle provided a protection factor of 65 and 43 per cent respectively.
4. The performance time of agility run was not affected by strapping, indicating that skillful strapping can give protection without hindering the required action of joints.
5. The purpose of this study was to suggest a method for testing the efficacy of strapping, and not to test the relative strappings used. For the latter, longer periods of activities will be required.
6. Electrogoniometry provides a useful means to record changes in the movement in joints, changes in the protective action of strappings <u>during activity.</u>

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TABLE 1. EFFECT OF AGILITY RUN UPON THE RANGE OF ANKLE JOINT MOVEMENT IN DEGREES. FIVE SUBJECTS WERE TESTED UNTAPED, IMMEDIATELY BEFORE AND AFTER THE RUN. THE TEST CONSISTED OF A VOLUNTARY MAXIMUM EXTENSION AND FLEXION OF THE FOOT.

Subjects	Untaped	T A P E D					
		Johnson & Johnson		Lonn-Mann		Springfield Modified	
		Before A.R.*	After A.R.	Before A.R.	After A.R.	Before A.R.	After A.R.
1	59.7	48.7	49.0	47.8	52.0	44.2	43.6
2	52.4	32.3	39.4	41.8	43.9	37.0	38.8
3	53.3	32.3	39.9	37.0	50.9	36.3	49.1
4	50.3	42.6	38.4	48.8	52.7	33.4	34.8
5	48.2	25.7	32.0	**	32.8	22.4	30.2
$\bar{X}$	52.80	36.30	39.70	43.80	46.50	34.70	39.30
SD	3.88	8.23	5.40	4.76	7.51	7.08	6.60
SEM	1.94	4.11	2.70	2.75	3.75	3.54	3.30
CV	7.35	22.66	13.58	10.85	16.16	20.43	16.79

	Johnson & Johnson			Lonn-Mann			Springfield Modified		
	r	t	p	r	t	p	r	t	p
Untaped vs. Before A.R.	0.74	5.53	0.01	0.18	3.21	<0.05	0.91	9.29	<0.01
Untaped vs. After A.R.	0.97	13.86	<0.01	0.61	2.11	>0.10	0.68	5.52	<0.01
Taped, before vs. After A.R.	0.85	1.49	>0.10	0.40	2.23	<0.10	0.74	1.87	>0.10

* A.R. - agility run; ** - because of technical difficulties, no recording was obtained.

TABLE 2. DEGREES OF FLEXION IN THE ANKLE JOINT CAUSED BY FIVE ONE-LEG-SQUATS. FIVE SUBJECTS WERE TESTED UNTAPED, IMMEDIATELY AFTER TAPING AND AGAIN AFTER THE AGILITY RUN.

Subjects	Untaped	T A P E D					
		Johnson & Johnson		Lonn-Mann		Springfield Modified	
		Before A.R.*	After A.R.	Before A.R.	After A.R.	Before A.R.	After A.R.
1	38.1	30.6	32.7	28.2	33.2	31.0	29.5
2	35.8	23.8	30.1	24.3	**	30.0	25.9
3	28.2	24.6	20.0	23.3	23.6	21.8	26.0
4	41.4	39.5	33.2	40.7	47.8	34.4	38.4
5	44.1	21.2	32.0	28.7	30.0	26.2	35.7
$\bar{X}$	37.50	27.90	29.60	29.00	33.60	28.70	31.10
SD	5.45	6.55	4.92	6.21	8.87	4.31	5.12
SE_M	2.72	3.27	2.46	3.10	5.12	2.15	2.56
CV	14.52	23.44	16.62	21.38	26.35	15.02	16.44

	Johnson & Johnson			Lonn-Mann			Springfield Modified		
	r	t	p	r	t	p	r	t	p
Untaped vs. Before A.R.	0.22	2.54	<0.10	0.62	3.31	<0.05	0.59	3.91	<0.02
Untaped vs. After A.R.	0.89	6.33	<0.01	0.94	1.60	>0.10	0.82	3.98	<0.02
Taped, before vs. After A.R.	0.39	0.51	>0.10	0.99	2.20	<0.10	0.51	1.04	>0.10

* A.R. - agility run; ** - because of technical difficulties, no recording was obtained.

TABLE 3. DEGREES OF ANKLE JOINT MOVEMENT AT VARIOUS REFERENCE POINTS AND THE RANGE OF MOVEMENT IN FIVE SUBJECTS DURING WALKING AND RUNNING—IN UNTAPED AND TAPED CONDITION.

Activity	Reference Points*	Untaped	Johnson & Johnson	Lonn-Mann	Springfield Modified	F**
	1	98.1	96.8	97.2	97.4	0.46
	2	83.2	85.5	84.8	84.5	1.89
Walk 1	3	101.3	98.9	99.4	100.4	0.90
	4	91.8	92.2	92.1	94.5	1.40
	Range of Motion	18.1	13.4	14.6	15.9	3.64
	1	99.1	96.7	97.6	98.4	1.52
	2	83.3	85.3	85.0	84.9	1.25
Walk 2	3	102.1	99.1	100.0	101.0	0.97
	4	92.3	92.8	92.7	94.9	1.15
	Range of Motion	18.8	13.8	15.0	16.1	0.60
	1	98.9	96.6	97.8	97.8	1.23
	2	83.4	85.7	85.2	84.1	2.78
Walk 3	3	102.1	99.3	100.2	100.1	1.02
	4	91.7	92.4	92.7	94.2	0.82
	Range of Motion	18.7	13.6	15.0	16.0	3.15
	1	99.2	97.1	97.0	99.6	1.47
	2	74.9	77.4	75.6	75.0	3.04
Run 1	3	105.0	101.4	101.7	103.3	1.08
	4	89.6	90.4	90.4	92.8	3.12
	Range of Motion	30.1	24.0	26.1	28.3	1.78
	1	99.2	97.1	97.5	99.8	2.14
	2	74.9	77.4	74.9	75.0	1.33
Run 2	3	105.0	101.4	102.2	103.5	1.04
	4	89.6	90.4	91.0	92.5	0.88
	Range of Motion	30.1	24.0	27.3	28.5	2.25
	1	99.2	97.9	97.8	99.9	1.23
	2	74.4	76.9	75.1	74.8	2.78
Run 3	3	105.2	101.9	103.4	103.6	1.02
	4	90.7	90.7	91.1	92.3	0.82
	Range of Motion	30.8	25.0	28.3	28.8	1.22

* See Figure 1; ** Threshold of significance - F = 3.16

TABLE 4. AGILITY RUN TIMES IN SECONDS.

Subject	Untaped	Johnson & Johnson	Lonn-Mann	Springfield Modified
1	14.8	14.9	14.9	14.8
2	16.3	16.3	15.9	16.1
3	14.3	14.2	14.3	14.8
4	14.5	15.1	15.3	14.8
5	14.7	15.0	14.9	14.6
$\bar{X}$	14.92	15.10	15.06	15.02
SD	0.71	0.68	0.53	0.55
SE_M	0.35	0.34	0.26	0.27
CV	4.75%	4.50%	3.51%	3.67%

	r	t	p
Untaped vs. Johnson & Johnson	0.94	1.64	>0.10
Untaped vs. Springfield Modified	0.85	0.74	>0.10
Untaped vs. Lonn-Mann	0.95	0.77	>0.10